New Features of HEC-RAS 4.0

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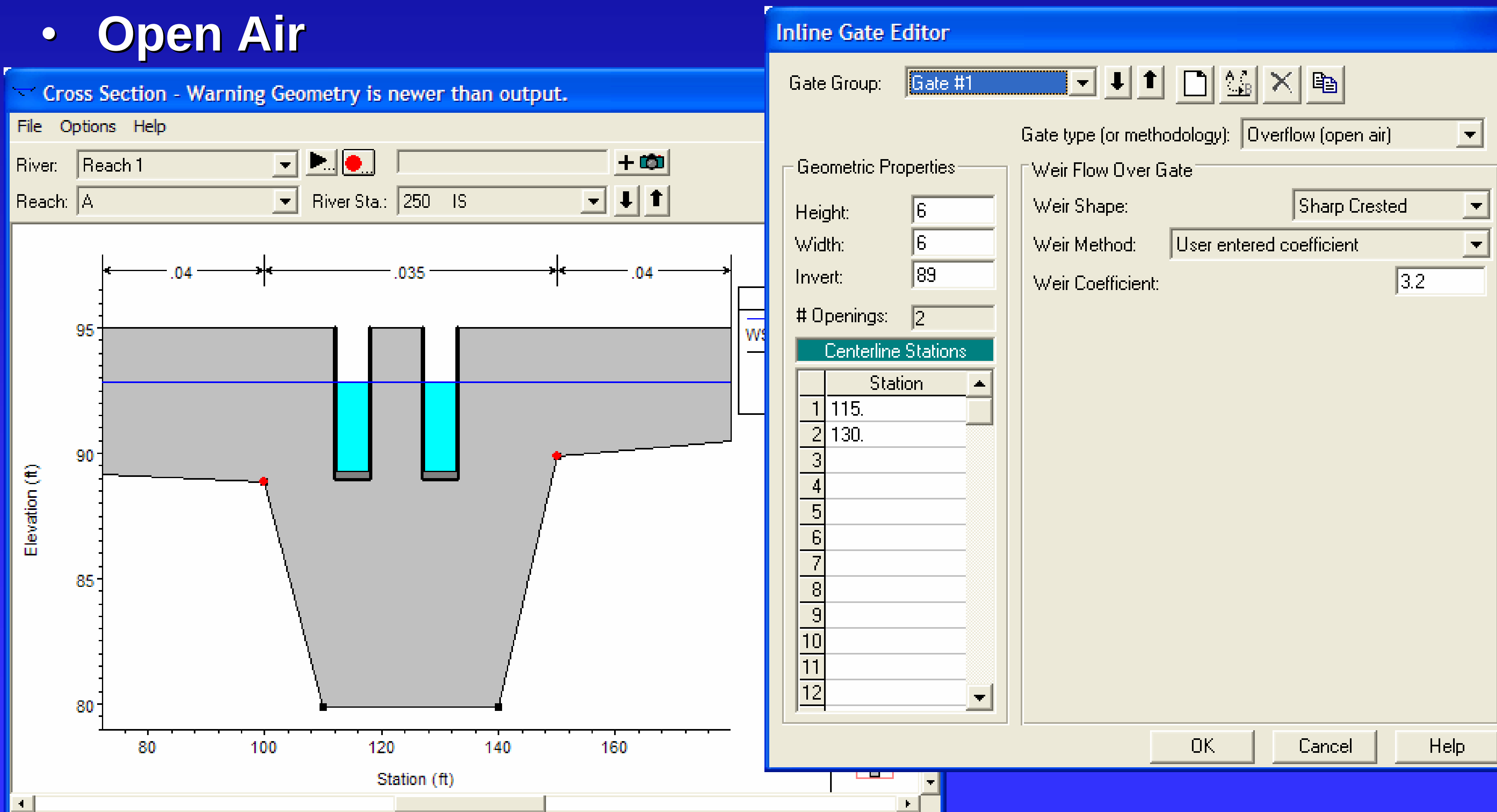
New Features in HEC-RAS 4.0

- Overflow Gates
- User Defined Rules for Gate Operations
- Pressure Flow in Pipes
- Pump Station Rules
- Hager’s Lateral Weir Equation
- Geo-referencing Tools
- Water Quality – Temperature Modeling
- Sediment Transport (erosion and deposition)

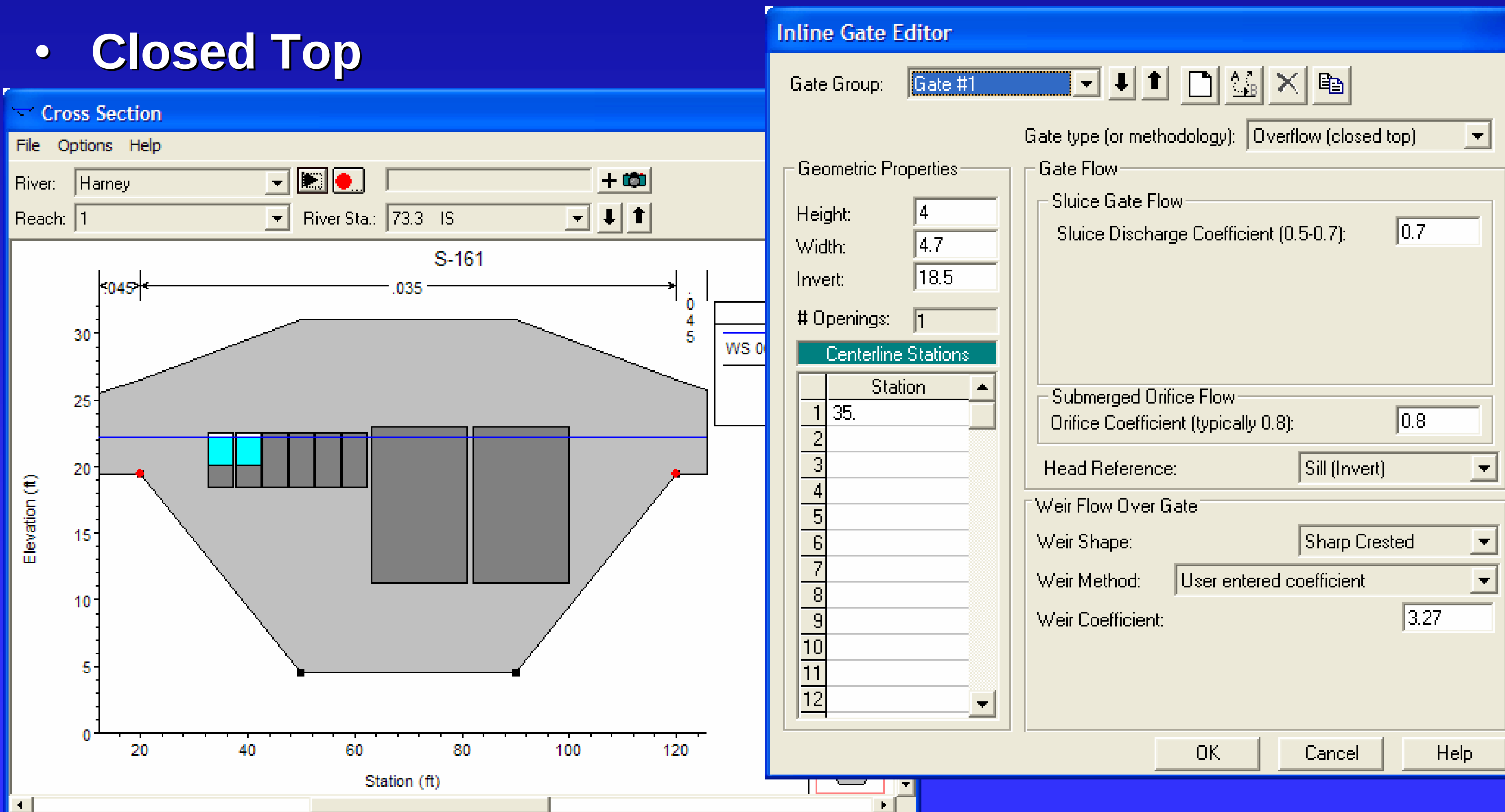
Overflow Gates

- **Open Air**

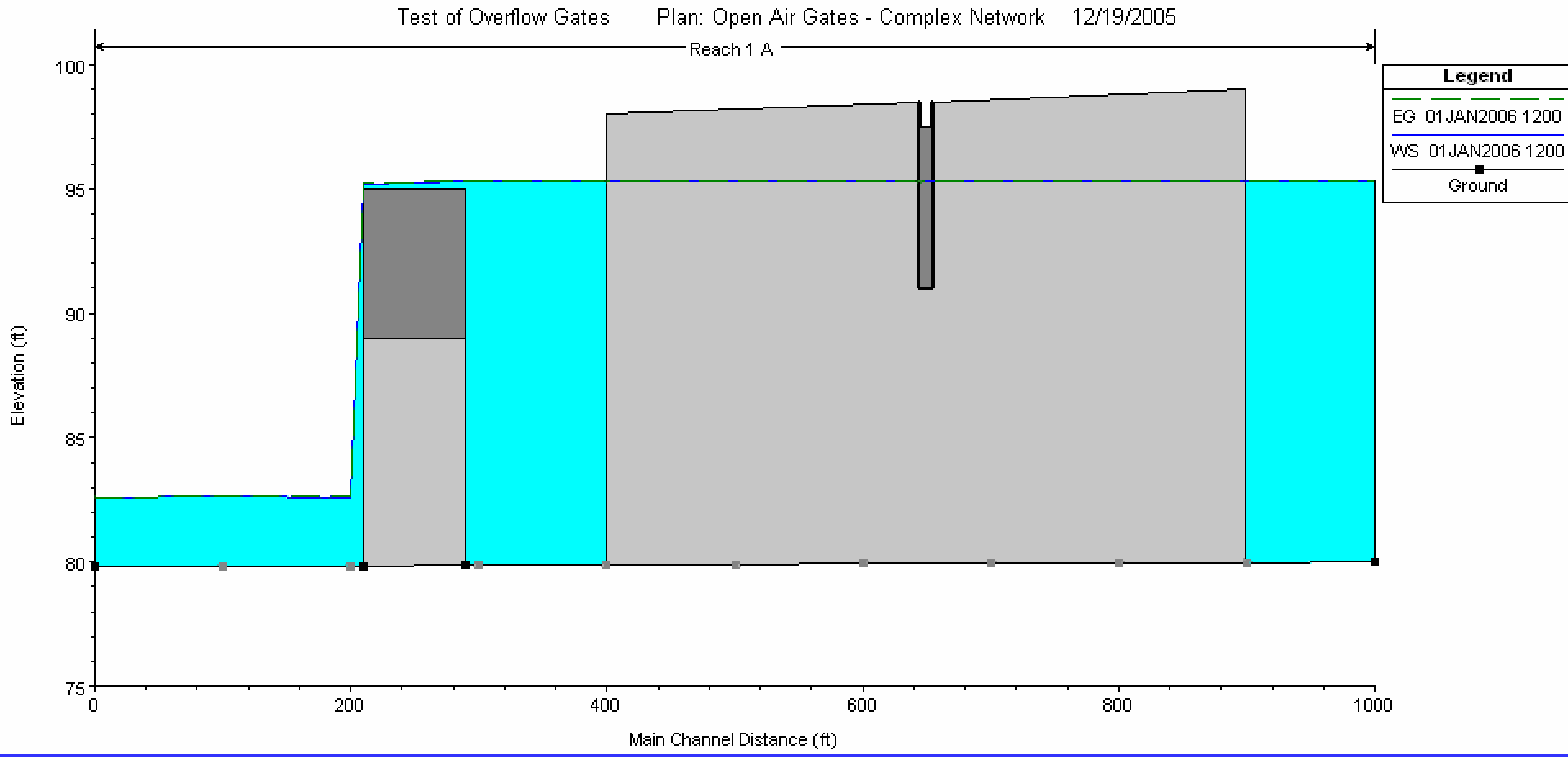


Overflow Gates

- **Closed Top**



Overflow Gates Example



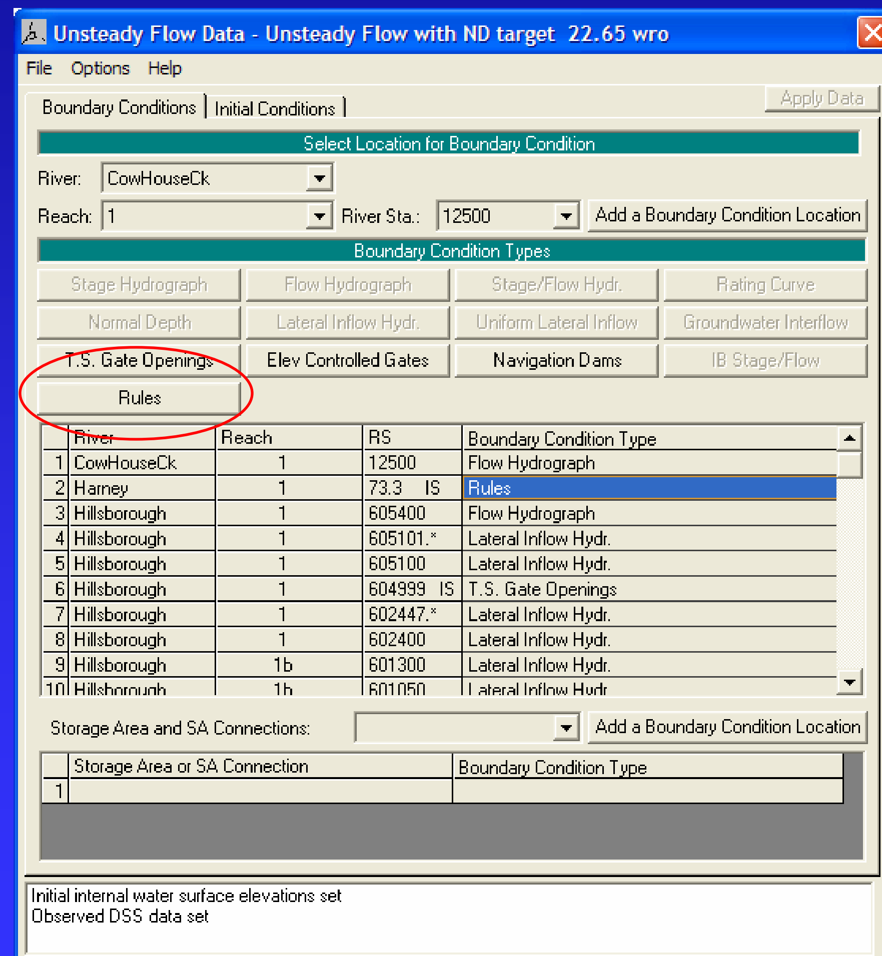
Operation Rules for Gated Structures

- Unsteady Flow Editor "Rules" boundary condition

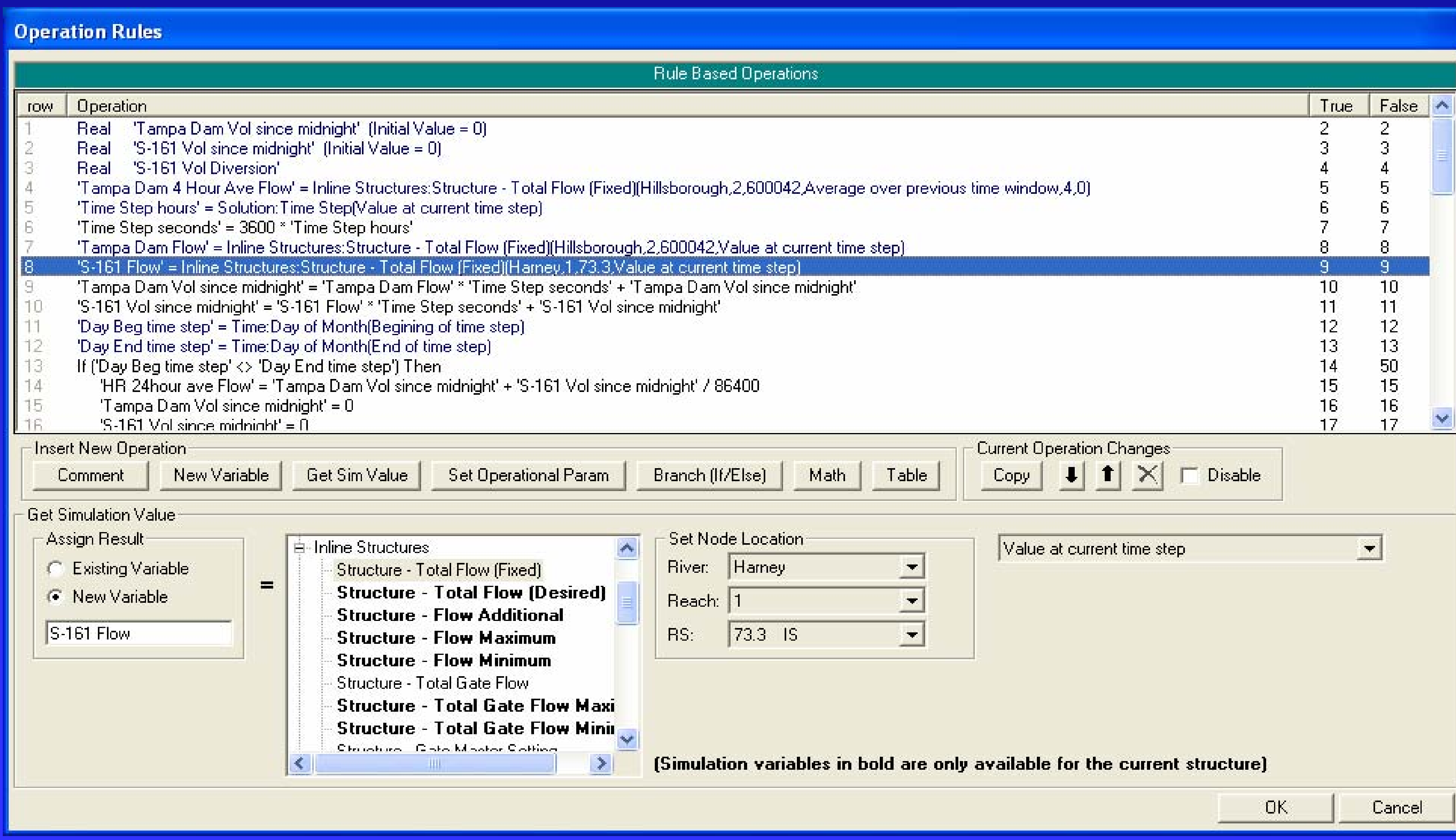
- Inline/Lateral Structures
- Storage Area Connections

- Controls
  - Gates
  - Weir Coefficients
  - Min/Max Flow

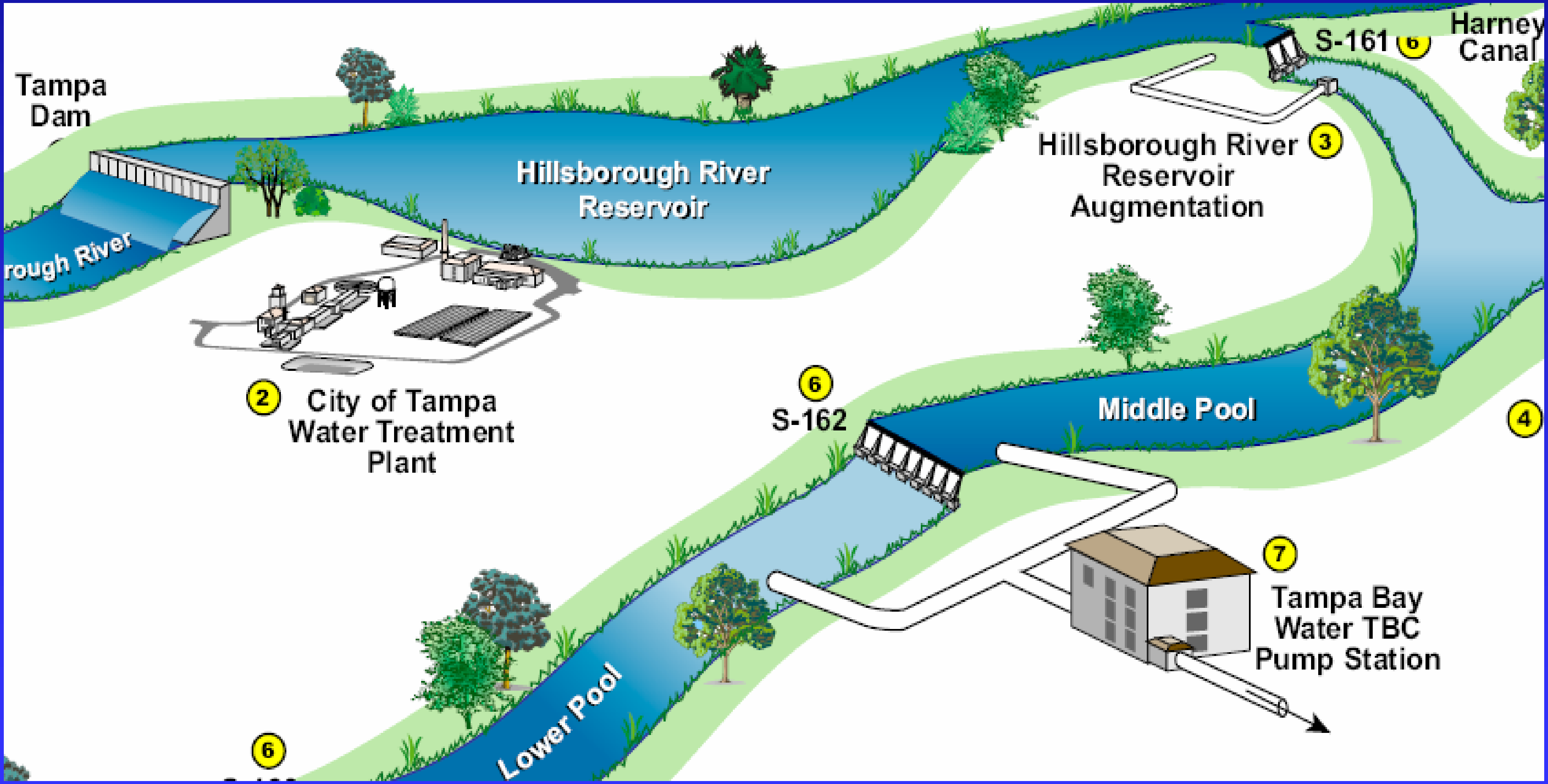
- Rules are evaluated at every time step



User Defined Rules Editor for Operating Gated Structures



Tampa Bay Water System Overview



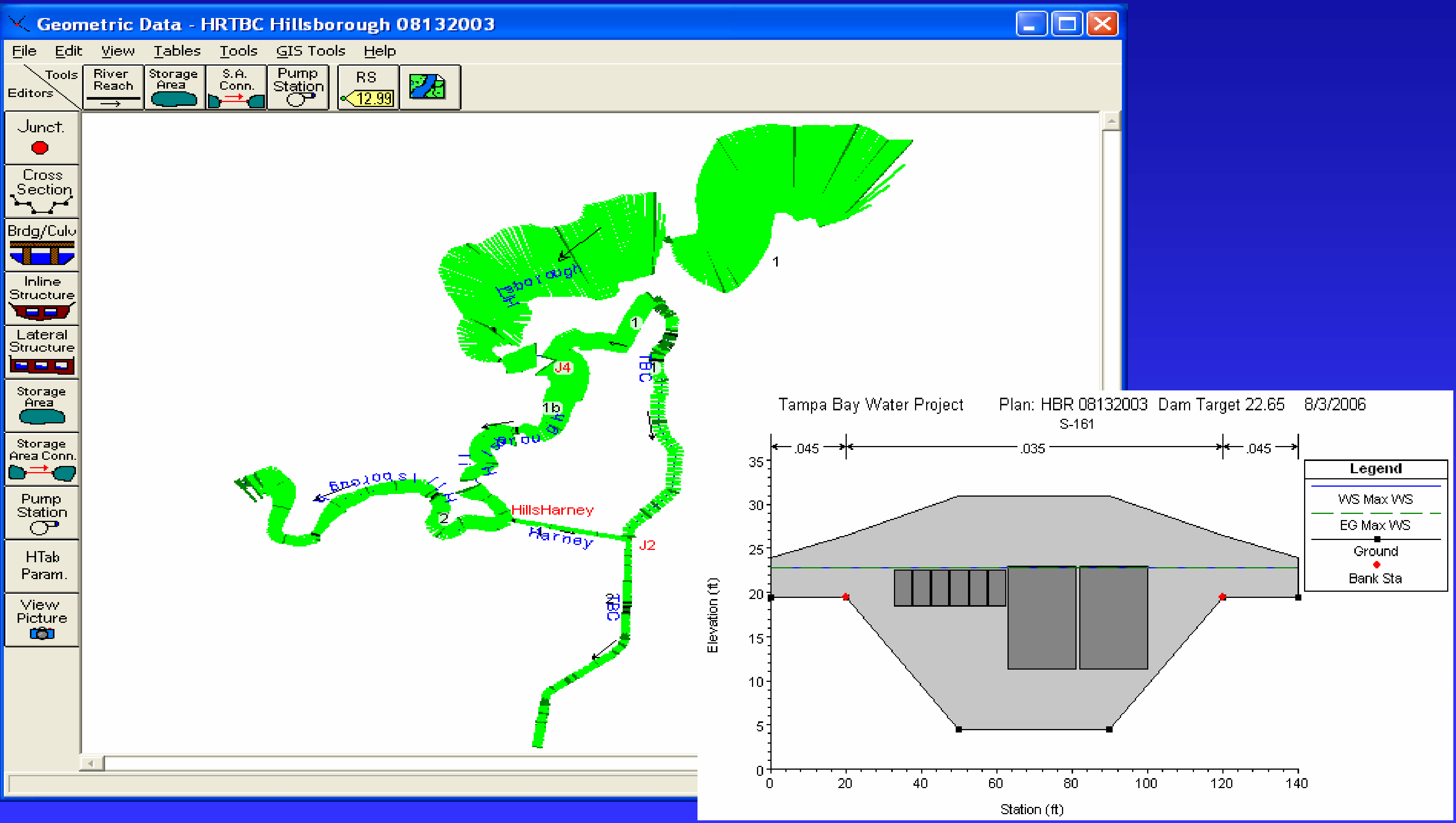
TBW S-161 Diversion Structure Rules

- Get previous 24 hour outflow
  - Outflow includes Tampa Dam & S-161
- Determine allowable diversion:

Discharge at Tampa Dam (mgd)	*Withdrawal from Middle Pool (mgd)*
Less than 65	0
65-97	10% of the discharge at Tampa Dam
97-139	10-30% of the discharge
139-647	30% of the discharge
More than 647	194

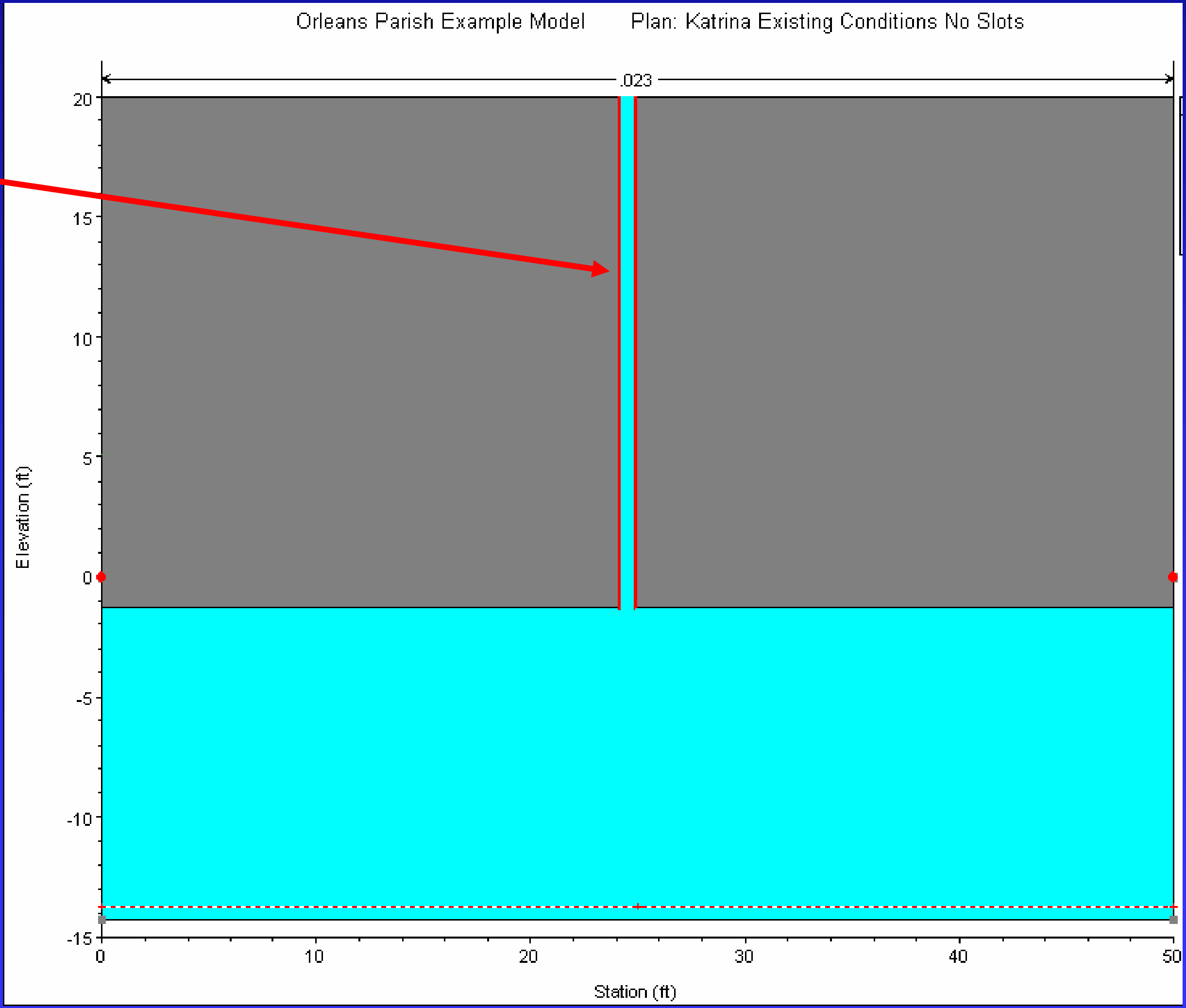
- Adjust S-161 gates to get allowable diversion in ~20 hours
- Close gates when/if:
  - Maximum volume diverted
  - 4 hour running average at Tampa Dam < 10cfs

Animation of Gate Operations
Tampa Bay Water Project Hillsborough River – Harney Canal



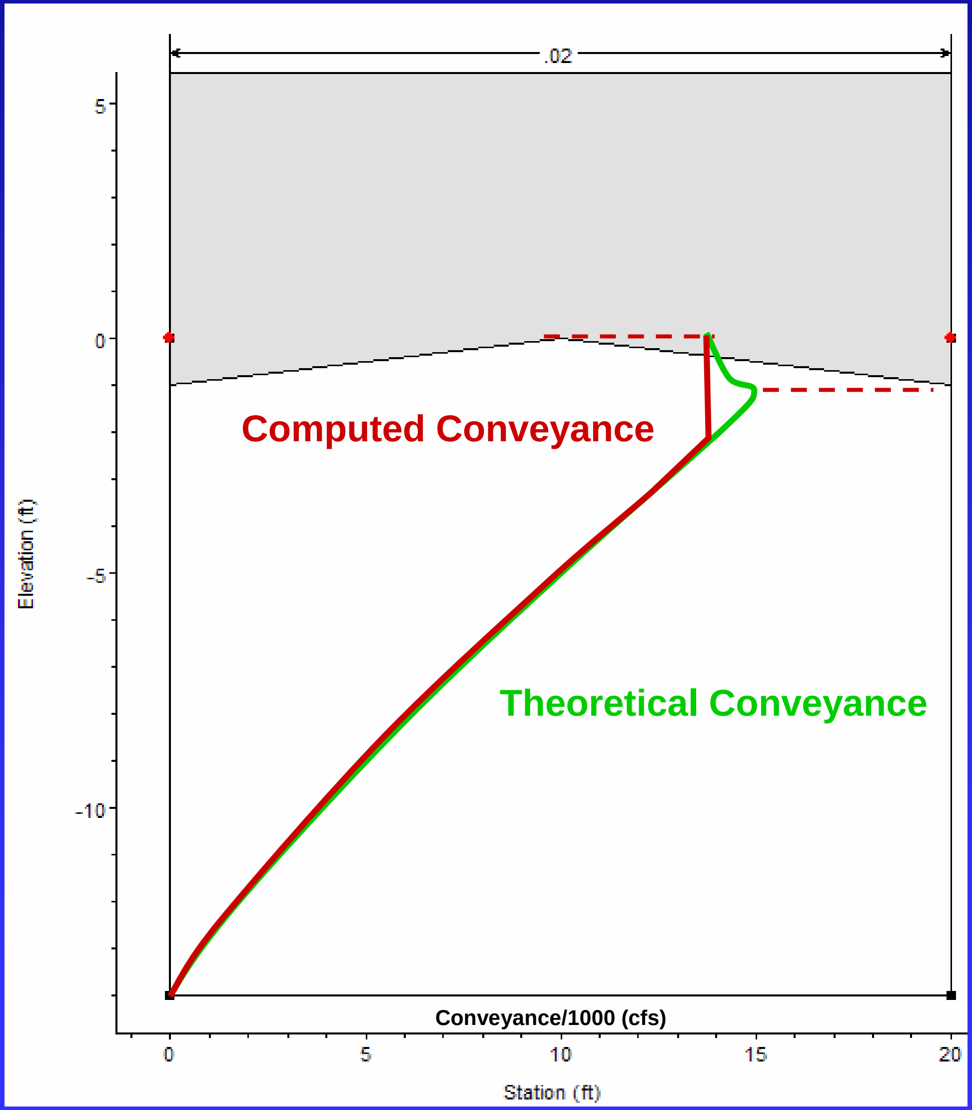
Pressurized Pipe Flow

- **Priessman Slot – insertion of an infinitesimal slot into the XS lid**
- **Any Pipe Shape**
- **Allows the water surface to rise to the pressure head (hydraulic grade line)**

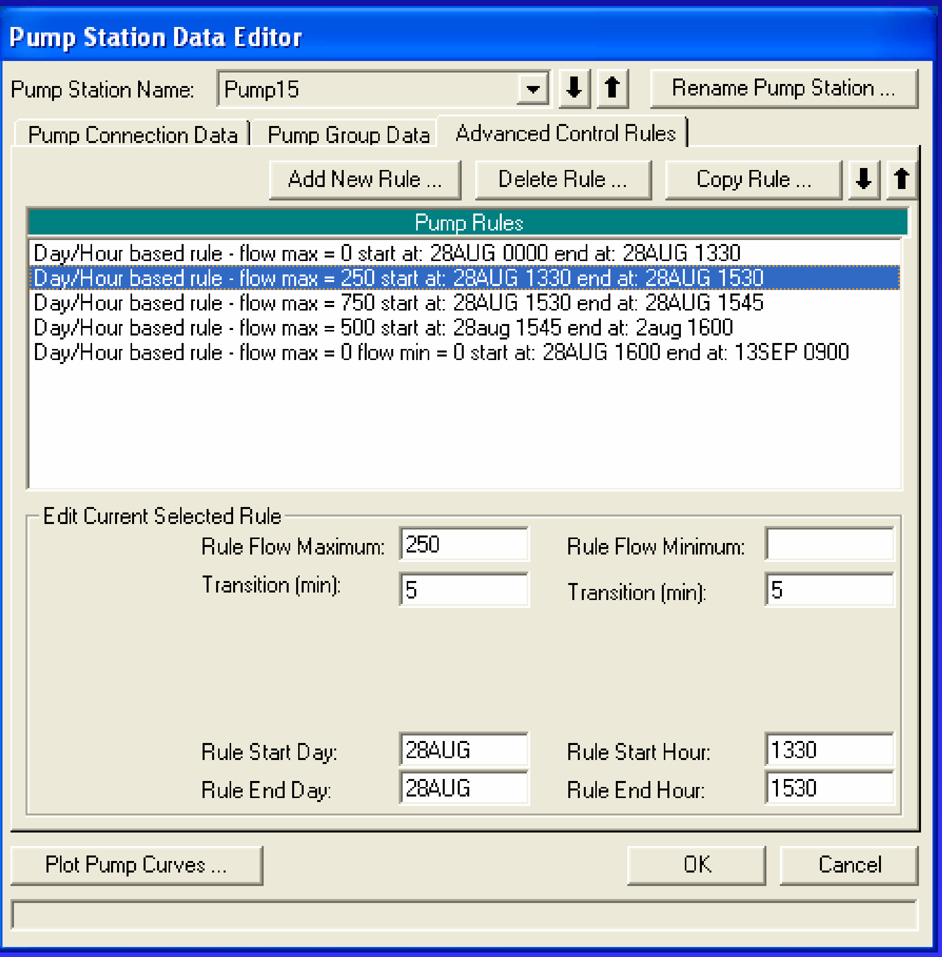


Pressurized Pipe Flow

- Conveyance and wetted perimeter are cut off at top of pipe
- Area is added, but it is negligible
- Conveyance curve is truncated to local minimum to increase stability

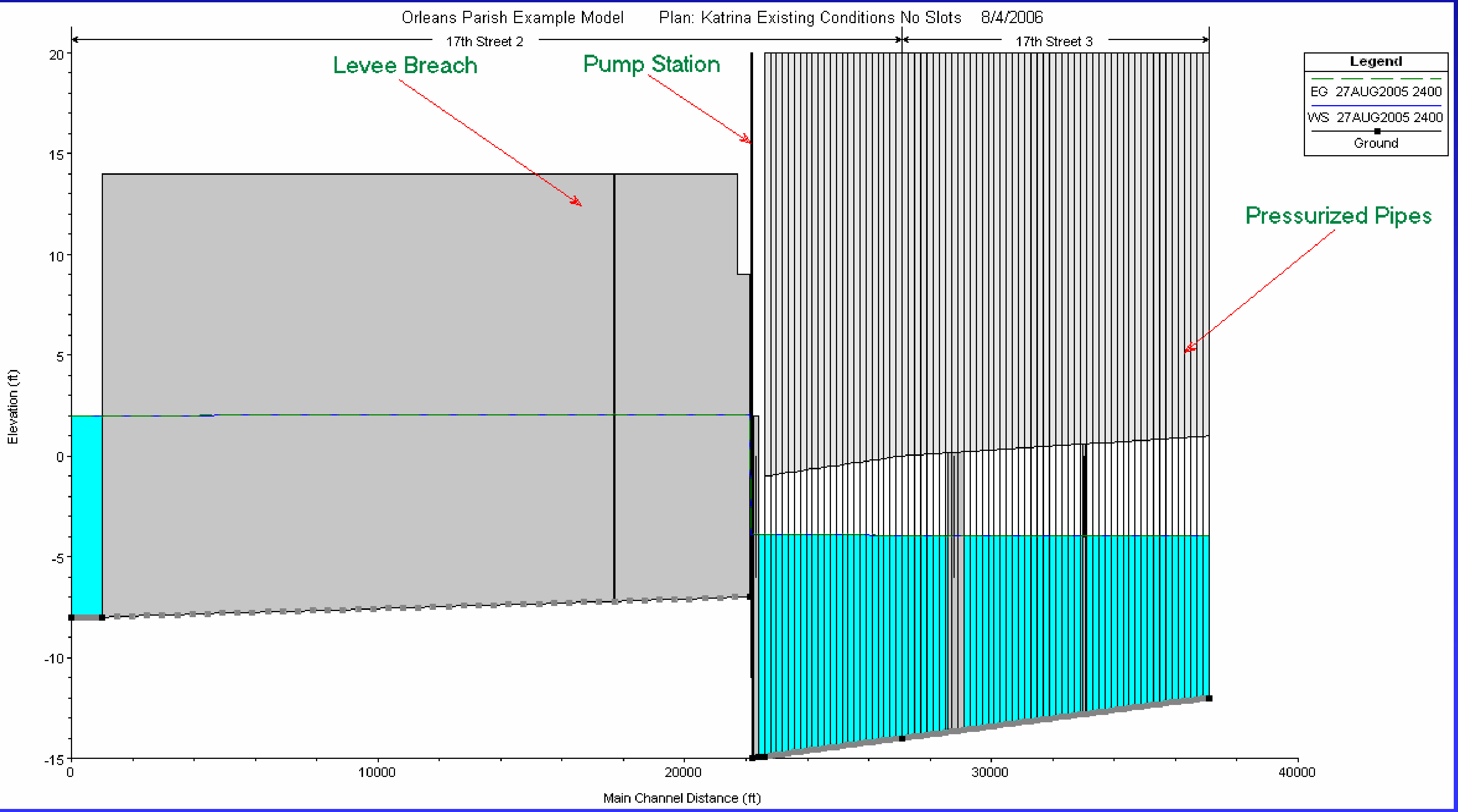


Pump Station Override Rules



New Orleans - 17th Street Pump Station

Pressurized Pipes, Pump Station, And Levee Breach Animation

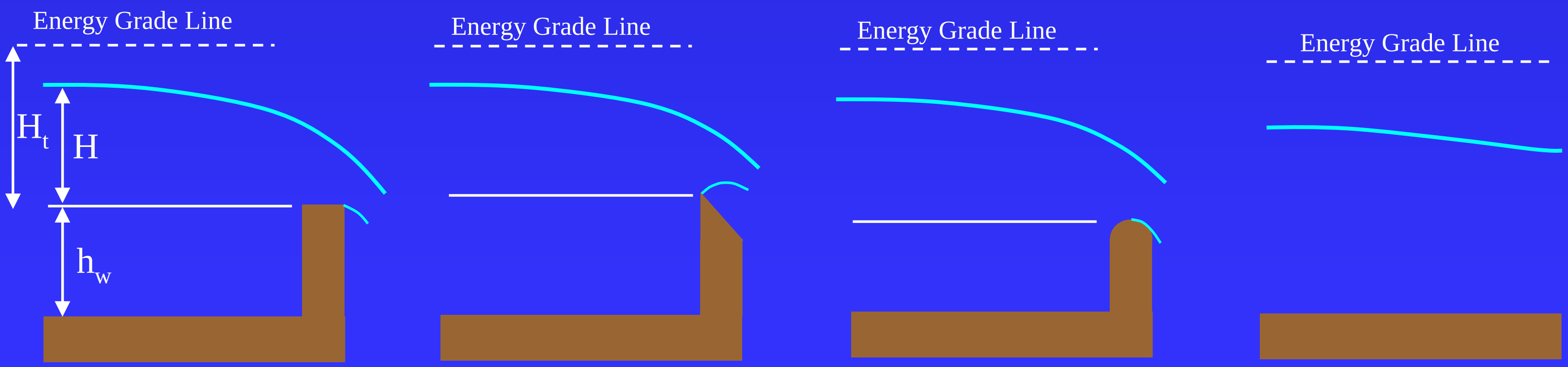


Hager's Lateral Weir Equation

$$Q = CLH^{3/2}$$

$$C = \frac{3}{5} C_0 \sqrt{g} \left[\frac{1-W}{3-2y-W} \right]^{0.5} \left\{ 1 - (\beta + S_0) \left[\frac{3(1-y)}{y-W} \right]^{0.5} \right\}$$

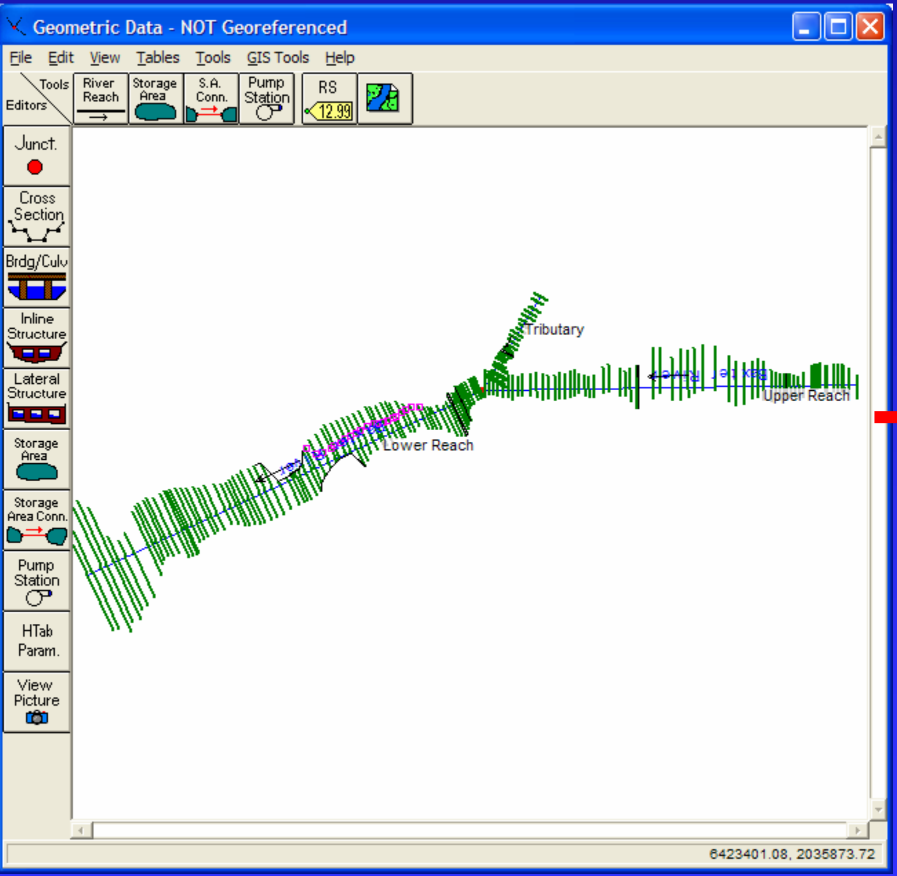
$$W = \frac{h_w}{H_t + h_w} \qquad y = \frac{H + h_w}{H_t + h_w} \qquad C_0 = Function(weir\ shape)$$

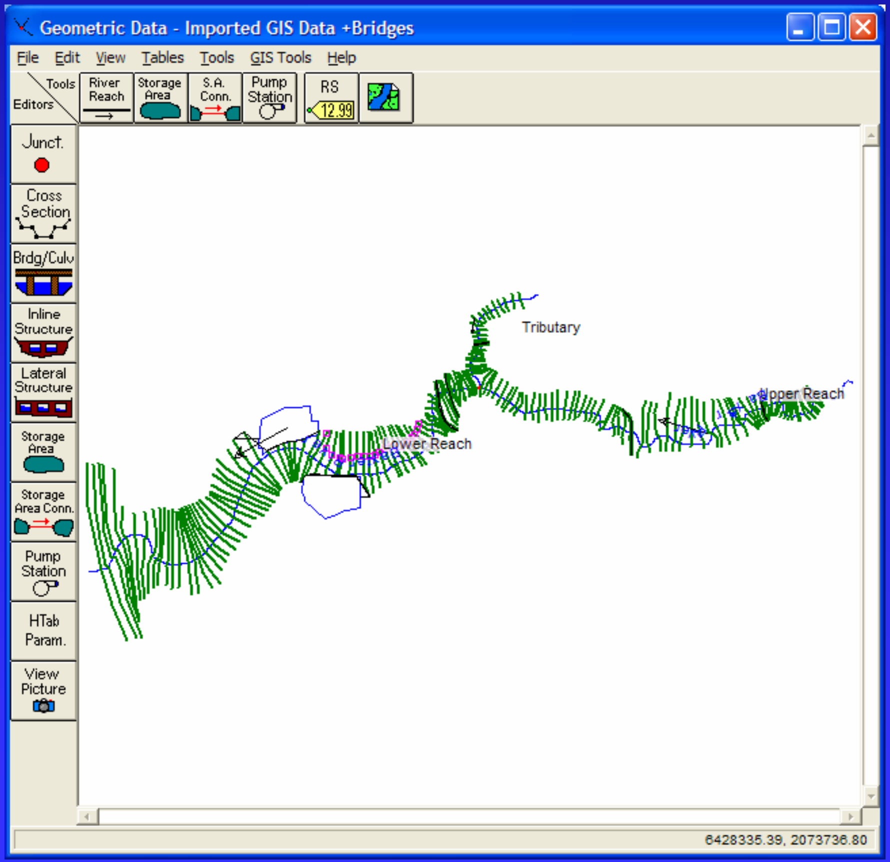


Broad Crested   Sharp Crested   Round/Ogee Crested   Zero Height Weir

Geo-referencing Tools in HEC-RAS

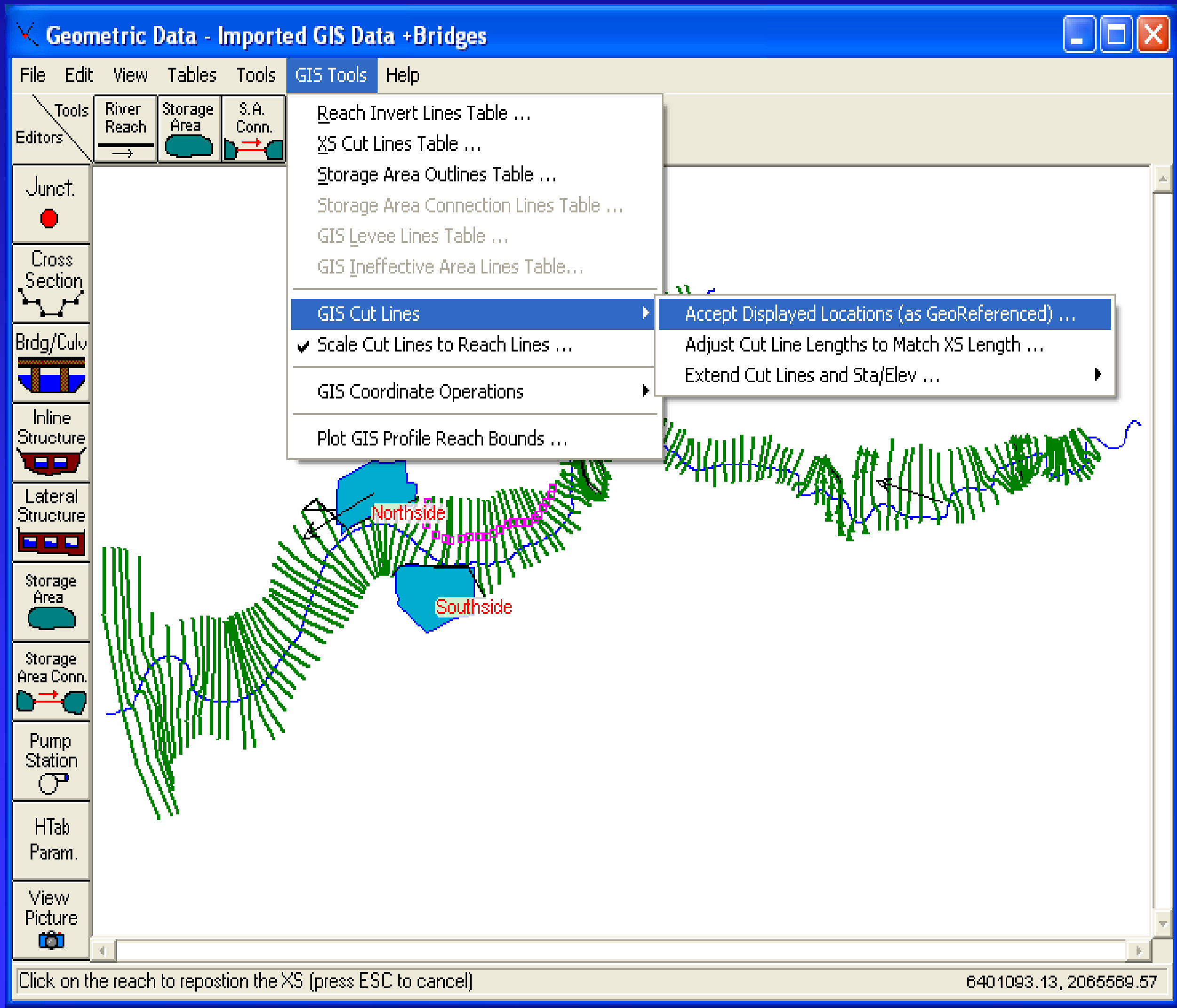
- From "stick figure" to real locations





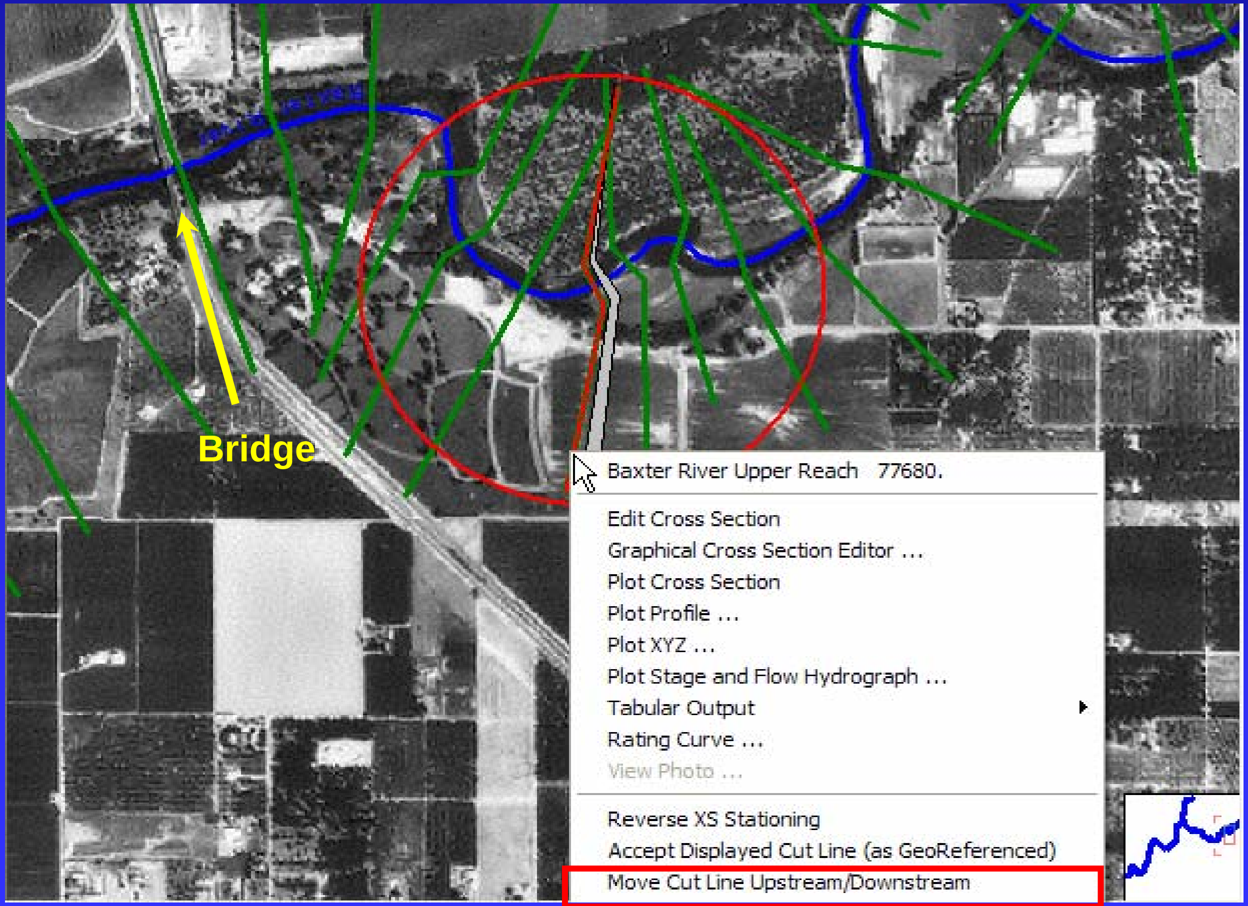
Geo- referencing Tools in HEC-RAS

- Fix the cross sections at "known" locations
- RAS will help move the rest of the sections



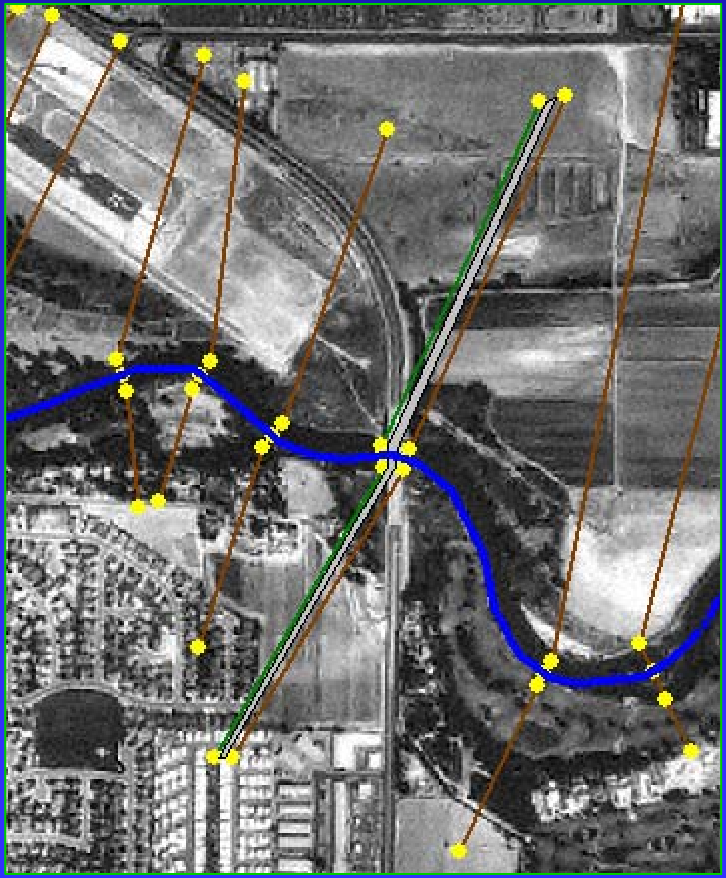
Geo-referencing

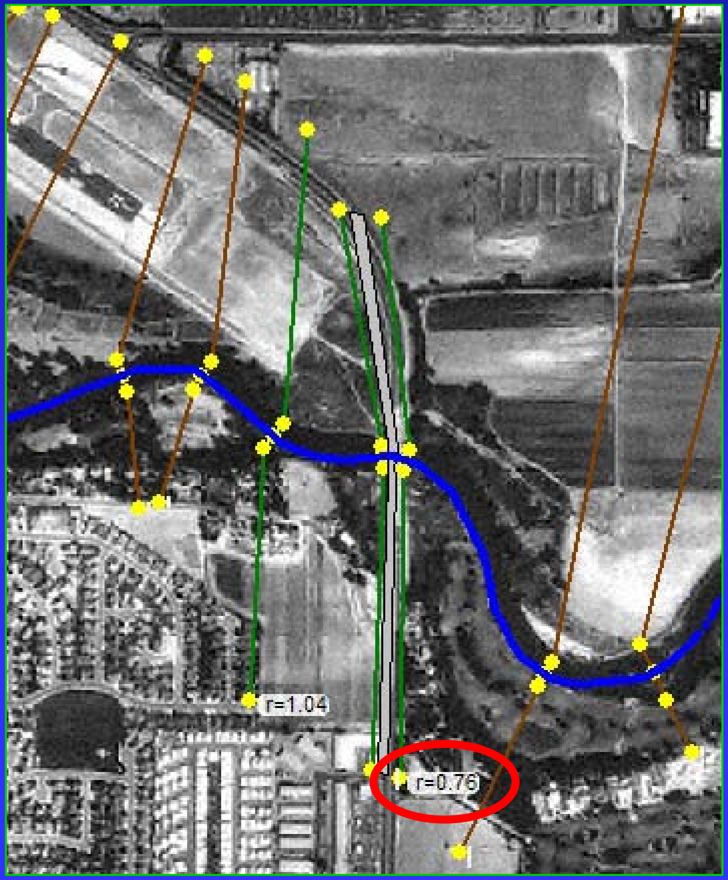
- **Move Cut Line Upstream/Downstream**



Geo-referencing

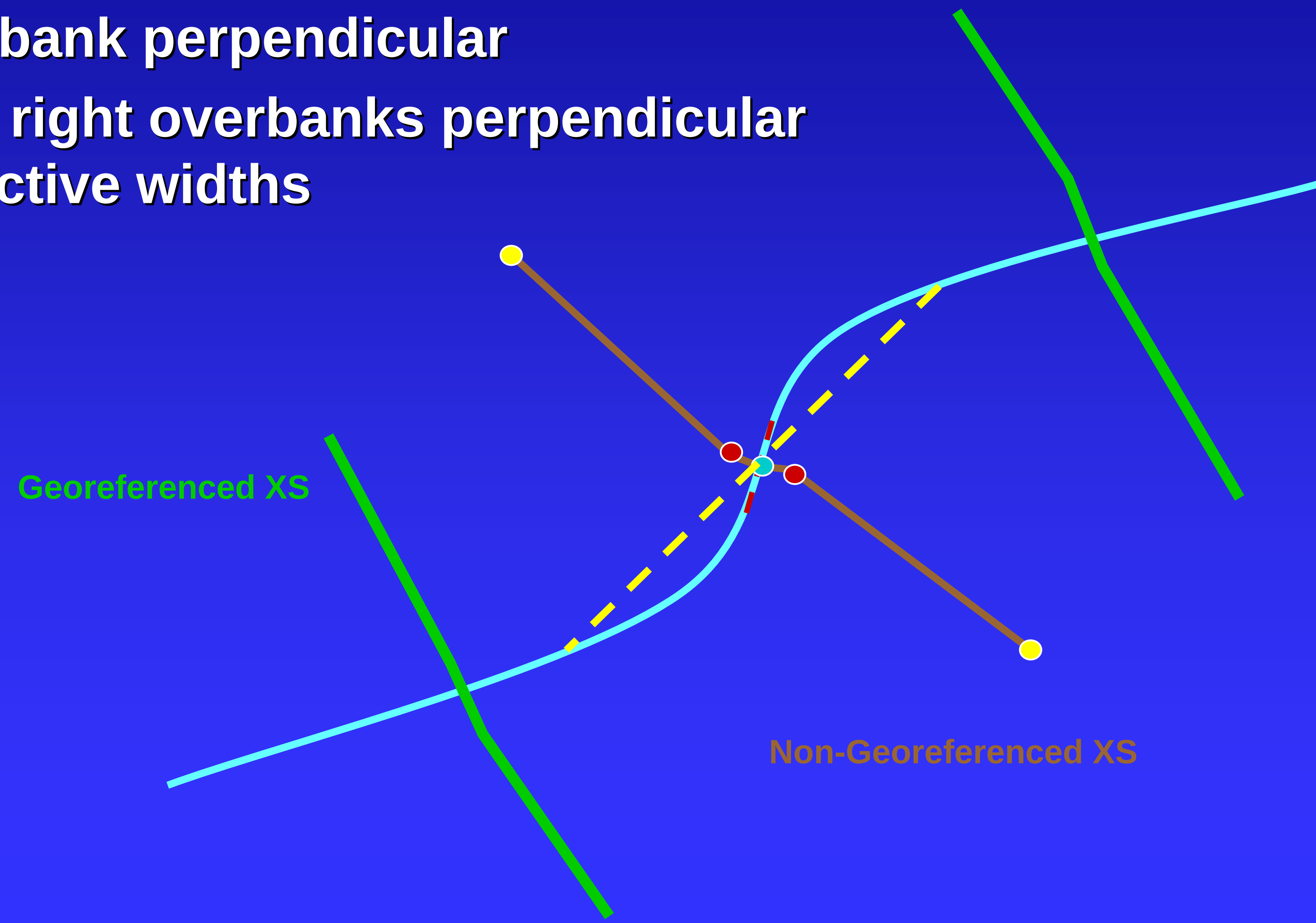
- **Edit | Move Object**





Geo-referencing: New XS Interpolation

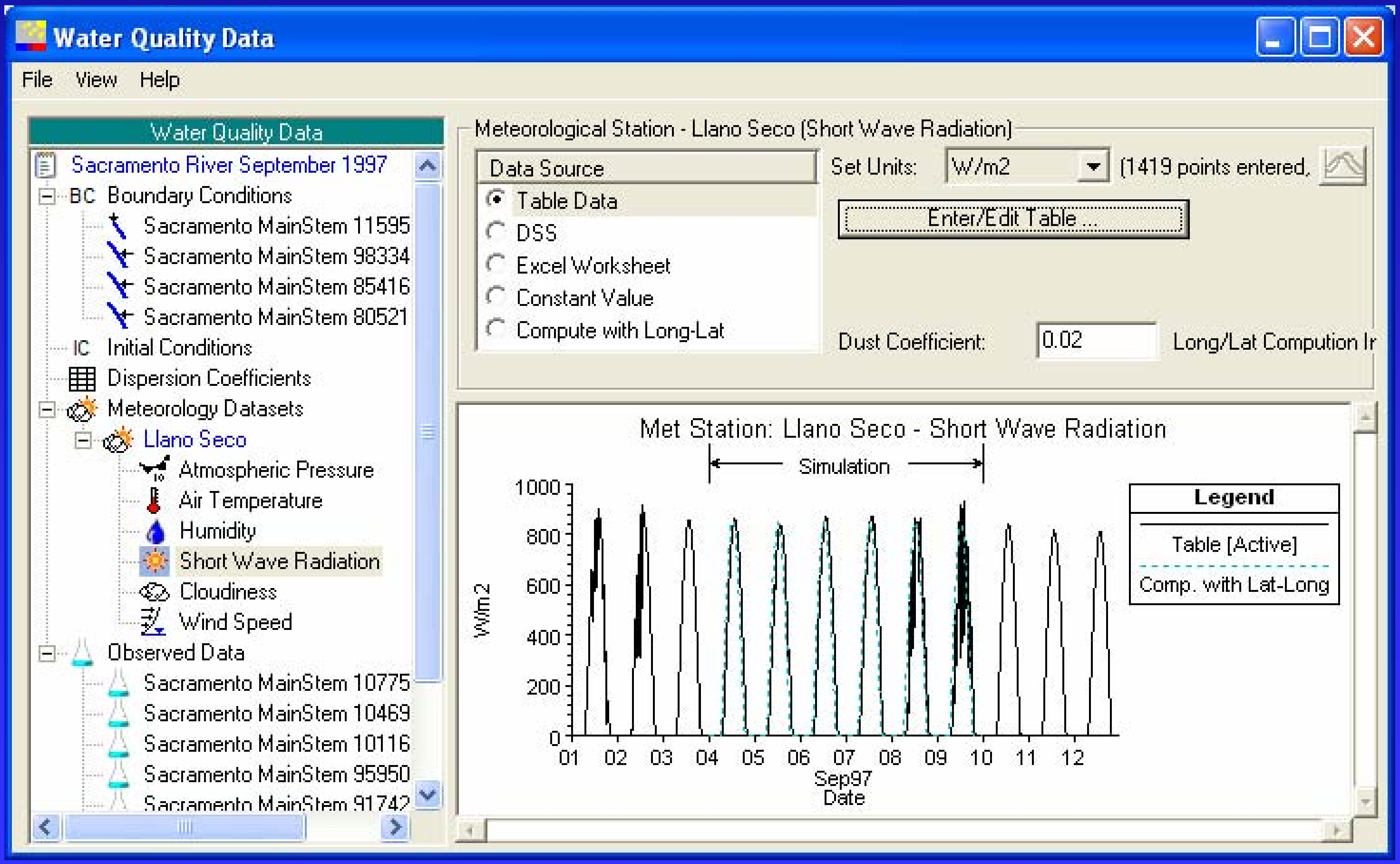
- Bank to bank perpendicular
- Left and right overbanks perpendicular to respective widths



Water Quality (Temperature) Model

- Based on unreleased version of CE-QUAL-RIV1
- Numerical Scheme
  - Finite Volume
  - Variable grid size
  - Automatic time step selection
- Full energy budget

Meteorological Data Editor – Solar Radiation



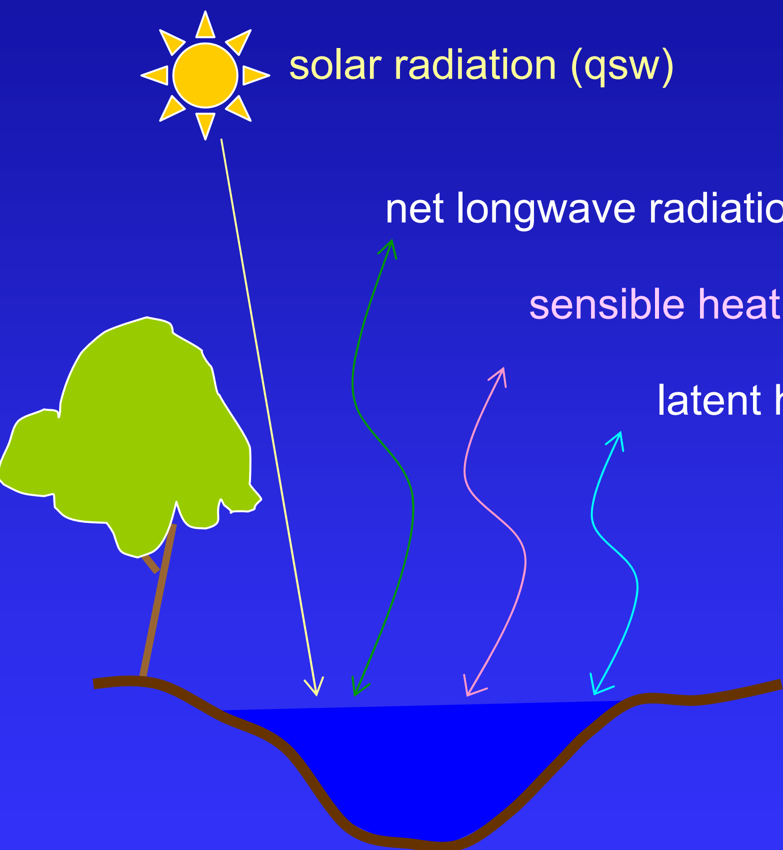
Source/Sink Term for Temperature (Energy Budget)

solar radiation (qsw) f (site location, time of day, day of year, atmospheric turbidity, cloud cover)

net longwave radiation (qlw) f (air temperature, water temperature)

sensible heat (qh) f (temperature gradient, wind, a&b)

latent heat (qe) f (vapor pressure gradient, wind, a&b)



$$q_{net} = q_{sw} + q_{lwn} + q_h + q_e$$

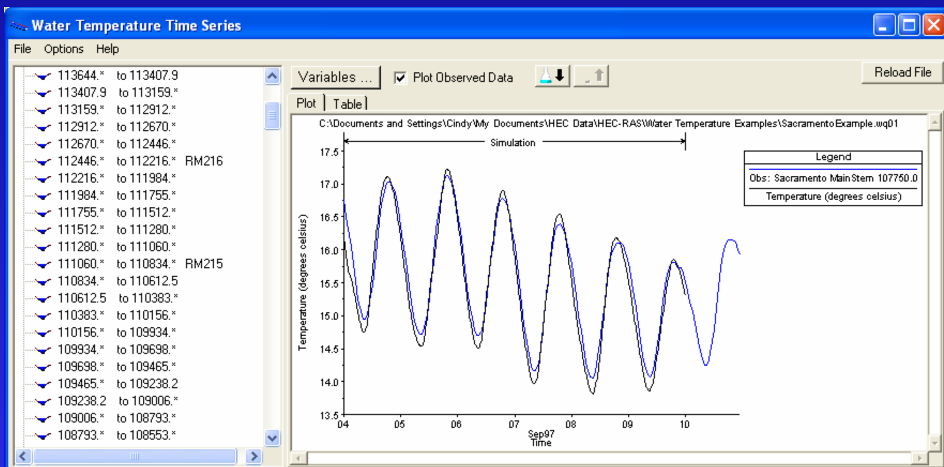
Planned:

- ground heat conduction
- shading (topographic, riparian)

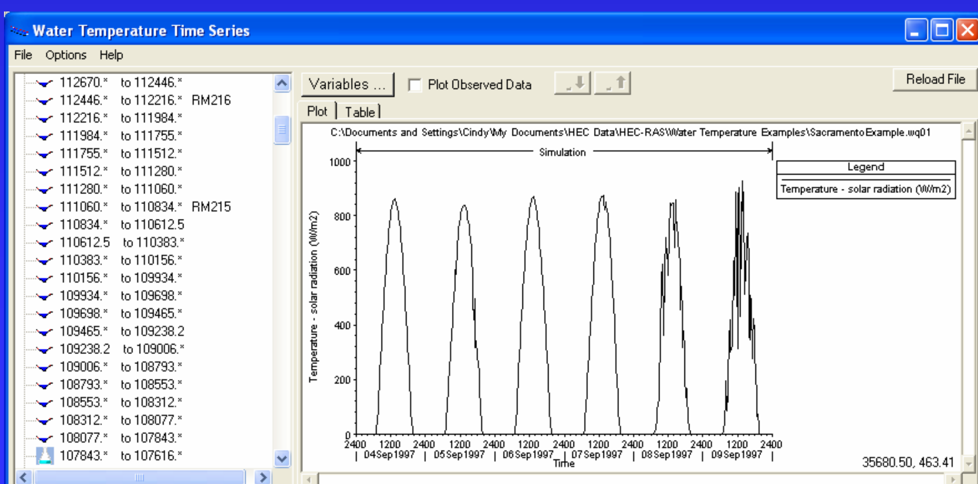
Hydrologic Engineering Center

System-Wide Water Resources Program SWWRP

Time Series Plots

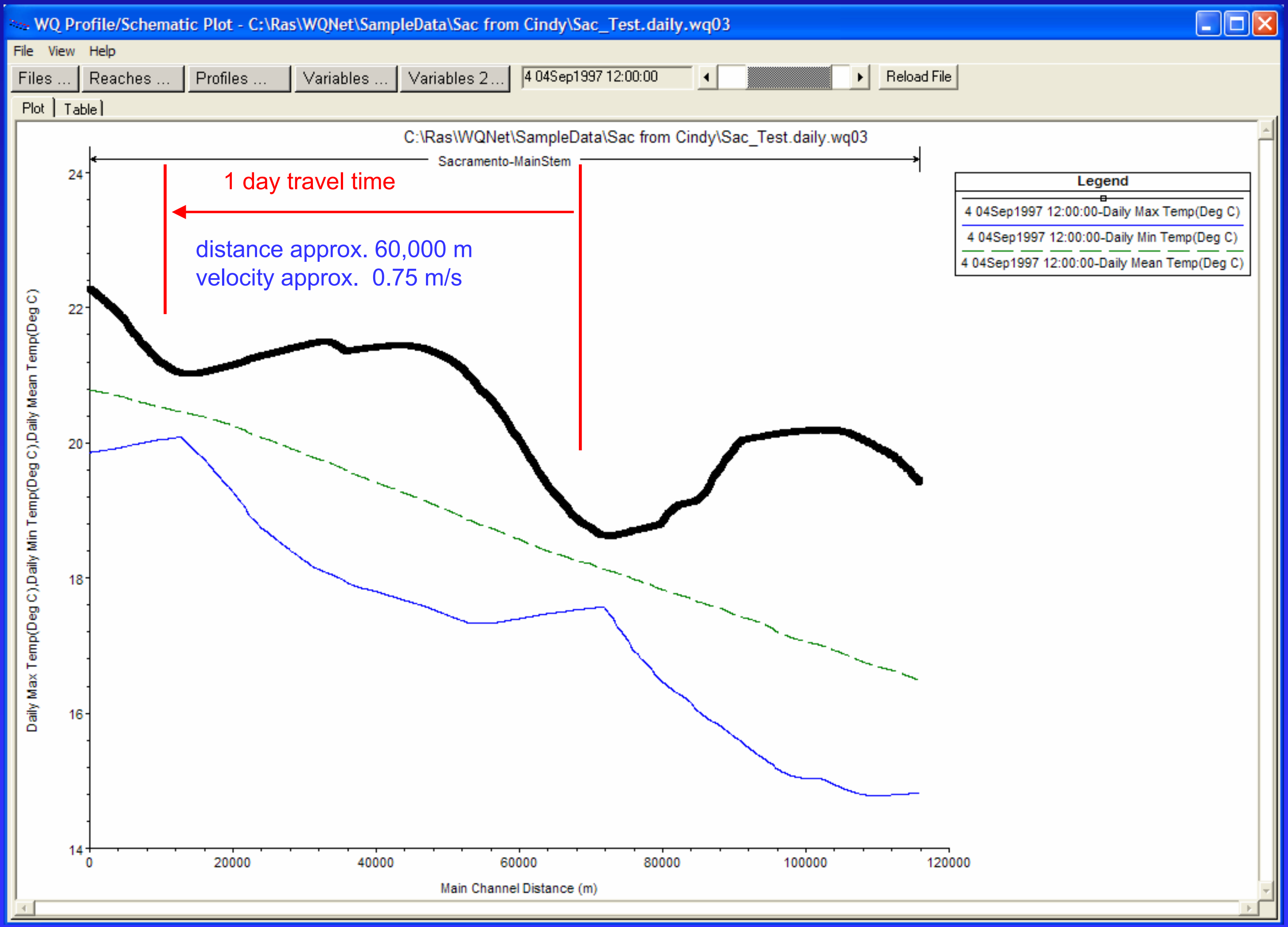


Water temperature

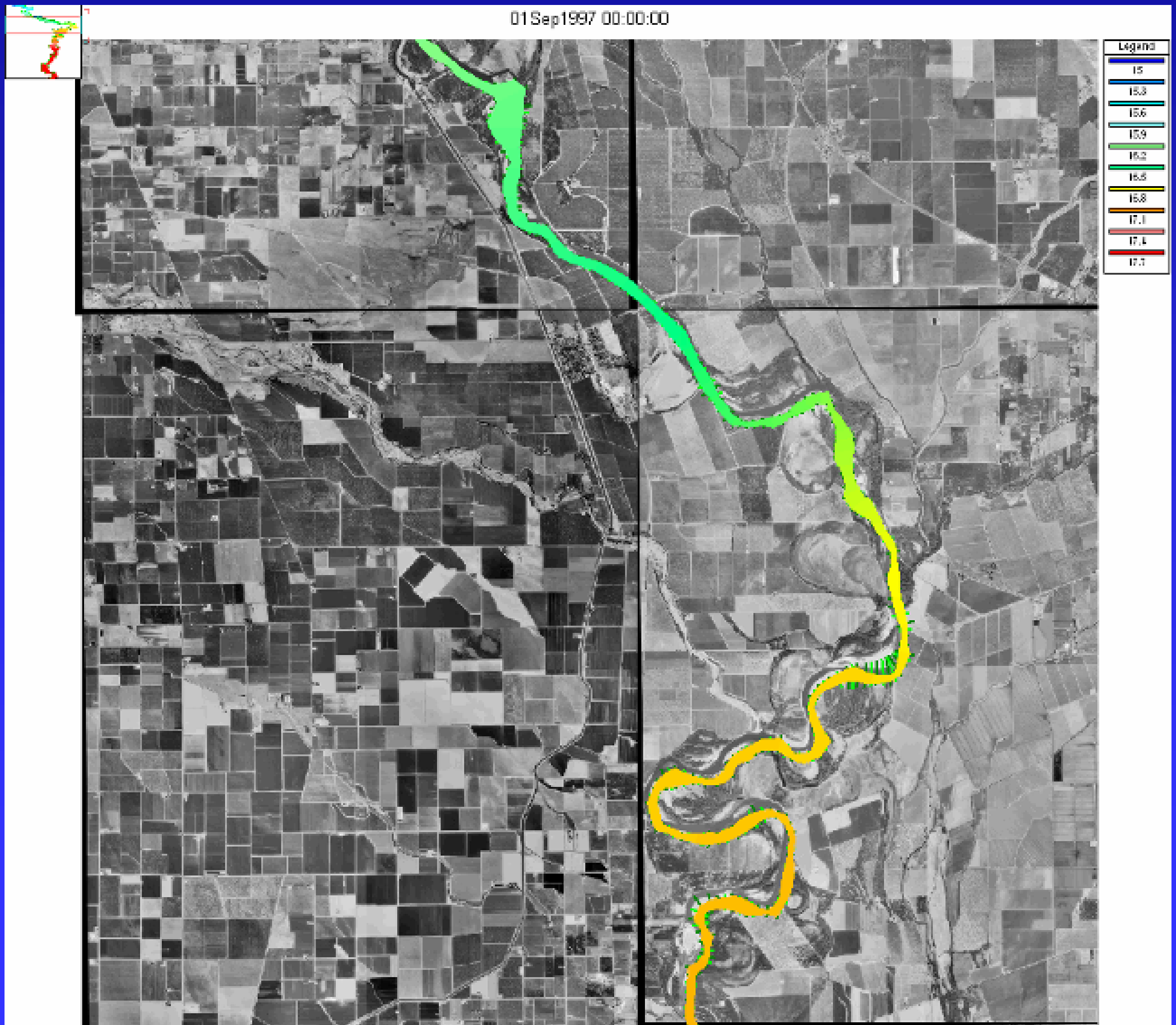


Solar Radiation

Profile Plot of Temperature



Map View


01Sep1997 00:00:00
Legend
15
15.3
15.6
15.9
16.2
16.5
16.8
17.1
17.4
17.7

Mobile Bed Sediment Transport

- Quasi-Steady Hydrodynamics
- Transport Capacity
- Sediment continuity
- Sorting and Armoring
- Erosion and Deposition
- Graphical User Design

Transport Potential Functions

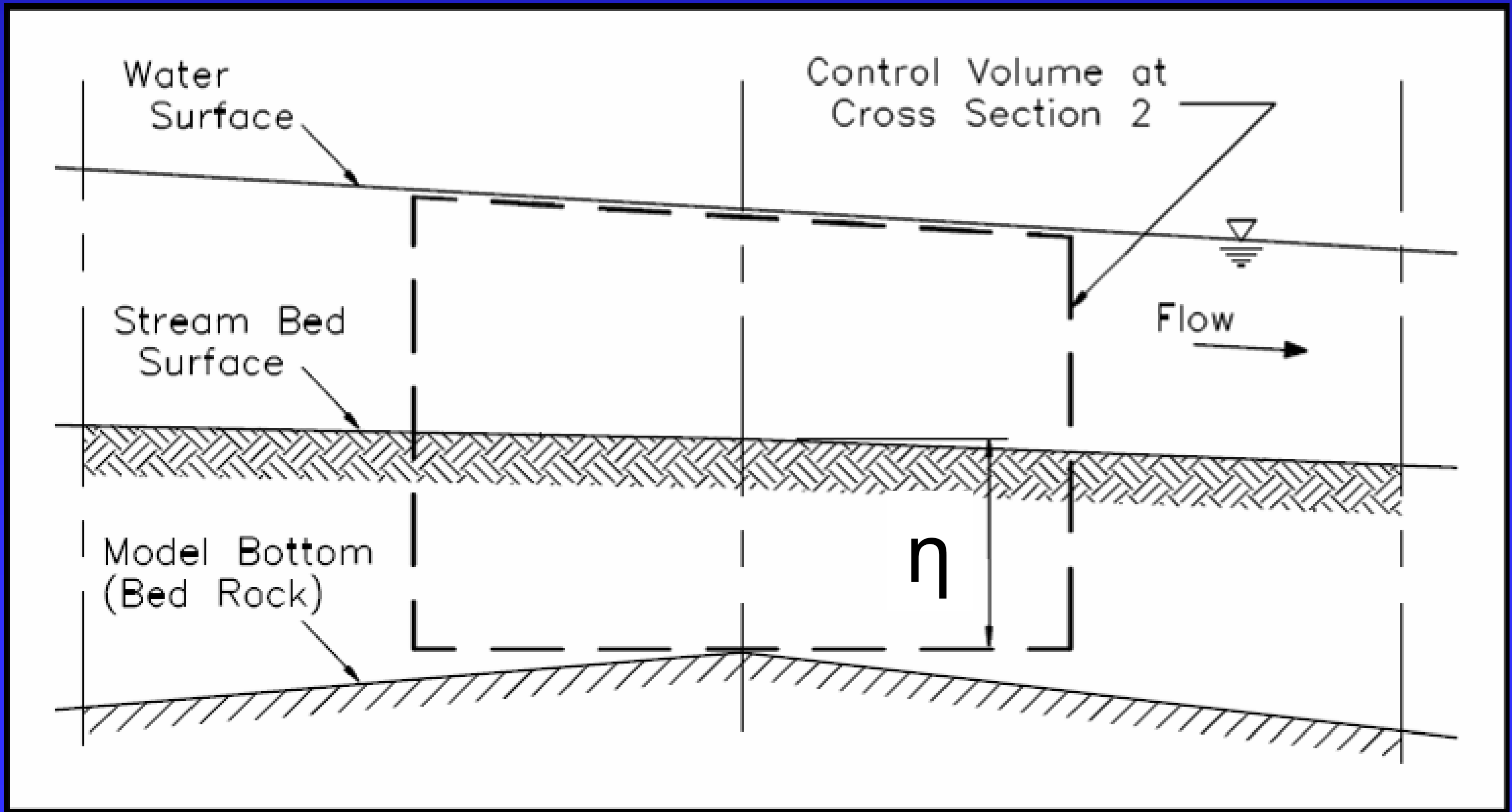
- Ackers-White
- Englund-Hansen
- Laursen (Copland)
- Myer-Peter-Meuler
- Toffaleti
- Yang (Sand and Gravel)
- Wilcock

Transport Capacity by Multiple Grain Sizes

- Bed Material and Inflowing Load divided into separate grain classes (up to 20)
- Transport potential is calculated for each grain size
- Transport Capacity = (Transport Potential for each grain size) X (fraction of that material in active layer of bed)

Sediment Continuity: Exner Equation

$$(1-\lambda_p)B\frac{\partial \eta}{\partial t} = -\frac{\partial Q_s}{\partial x}$$

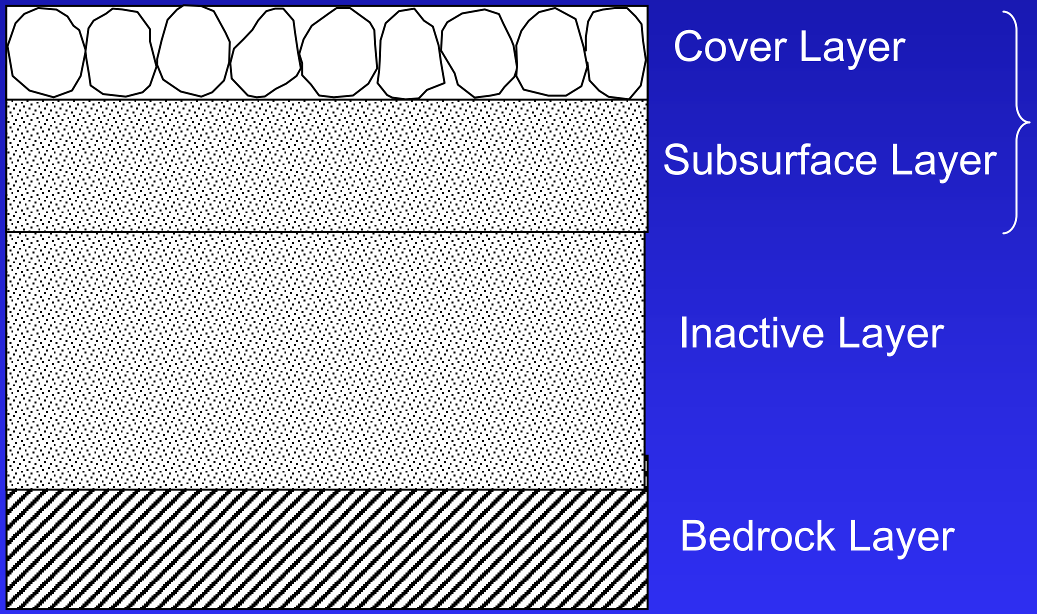


Temporal Constraints on Eroding and Depositing

- Erosion and deposition does not occur instantaneously.
- Deposition is based on settling velocity:
  - Deposition efficiency coefficient = $\dfrac{V_s(i)\cdot \Delta t}{D_e(i)}$
- Erosion is based on "Characteristic Flow Length"
  - Erosion = (Gs – Qs) x Ce   Entrainment Coefficient
  - Where:

$$C_e = 1.368 - e^{\frac{L}{30\cdot D}}$$

Sorting and Armoring



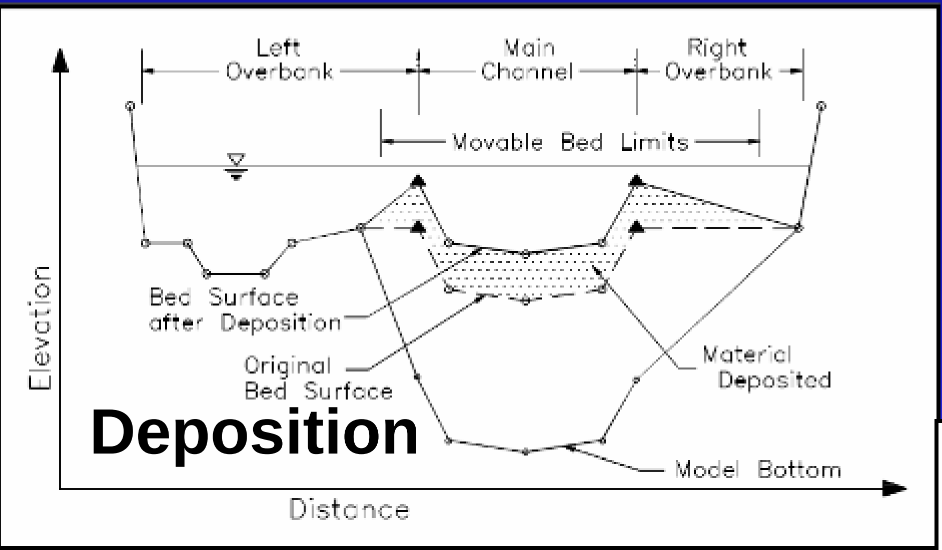
Diagramed and Conceptualized HEC 6 Code

Exner 5 implemented Currently in RAS

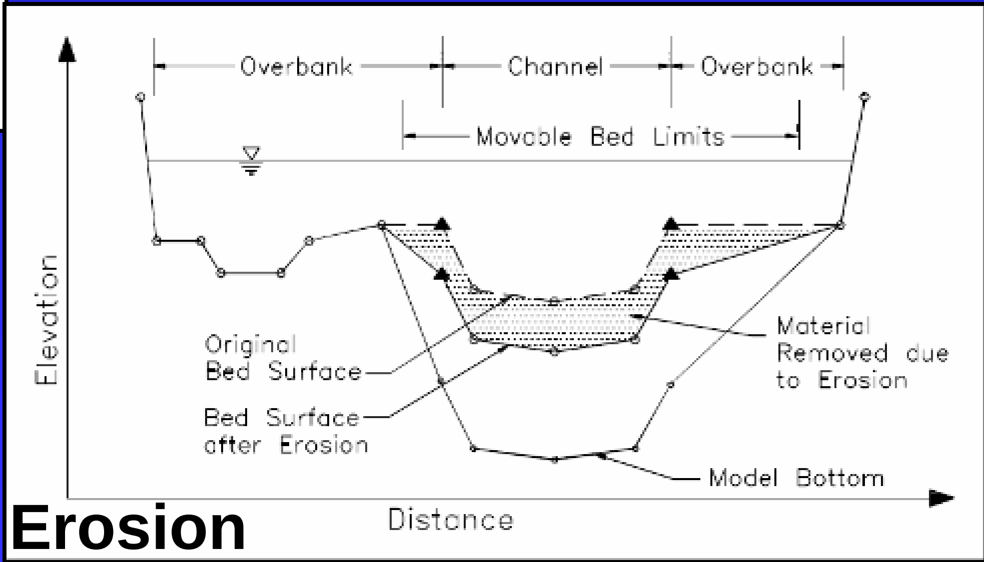
Also Simple Active Layer Method

* Erosion can be further constrained by the cover Layer

Erosion and Deposition to RAS Cross Sections

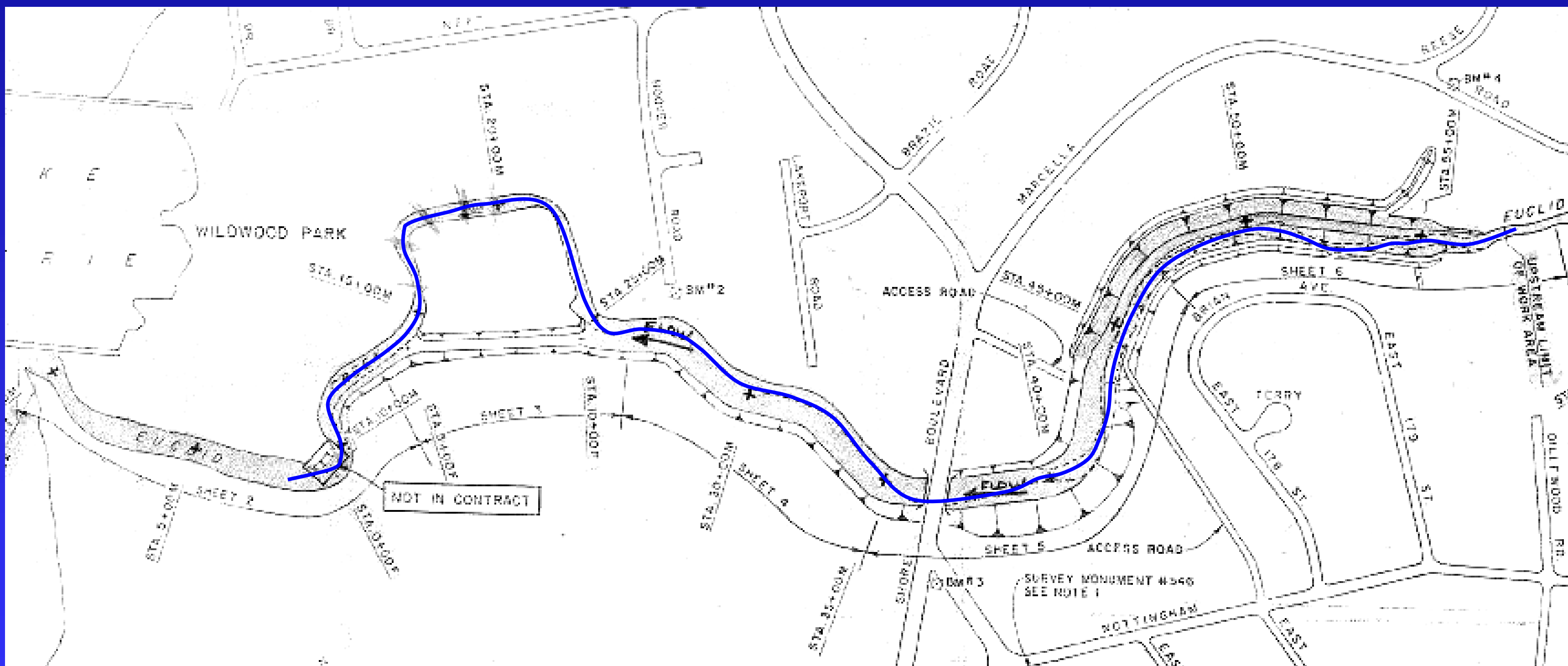


RAS computations modified to compute bed changes and modify cross sections before each time step



- **Cross Sections**
- **Bridges**

Example Application: Euclid Creek



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Case Study: Euclid Creek

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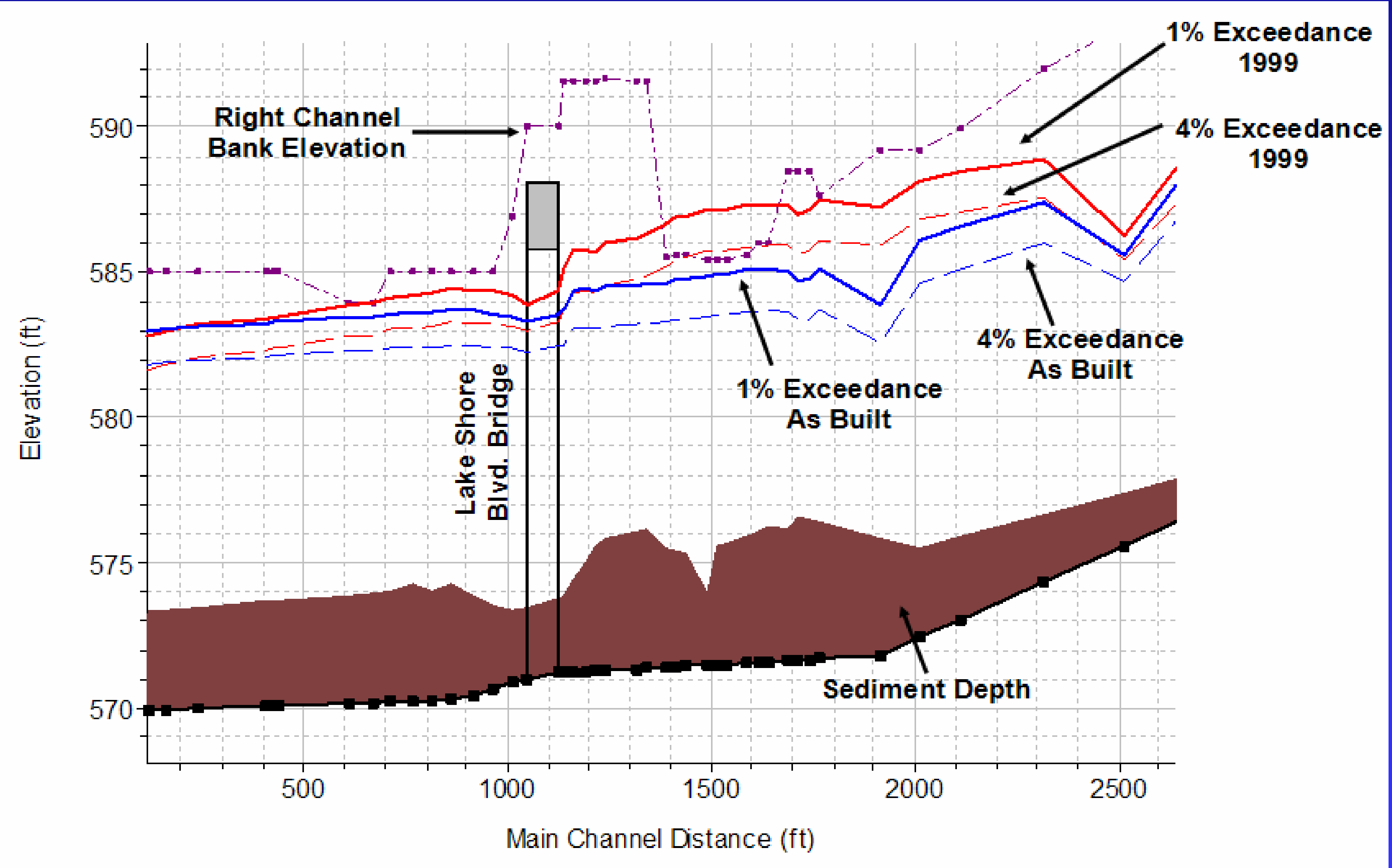

Animation of Bed Movement